POST MORTEM REPORT
1Q / 2007 D&R "MAJOR" S/D

4 CRUDE UNIT

Jan 15th – March 15th 2007

Compiled by:

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D&R Shutdown Engineer

CONTENTS

2.3 COLUMNS / VESSELS

C-1100 Atmospheric Column

Bottom Head and Vortex Breaker

Found in good condition. No work required.

Steam Spargers:

2 steam spargers were installed during the S/D. Sparger material is 825 Inconel see EWO BE301-E4. The spargers were 1.5' to 2' to short. The support clips to be made longer to compensate. One support clip was about 27 ¾" and the other 29".

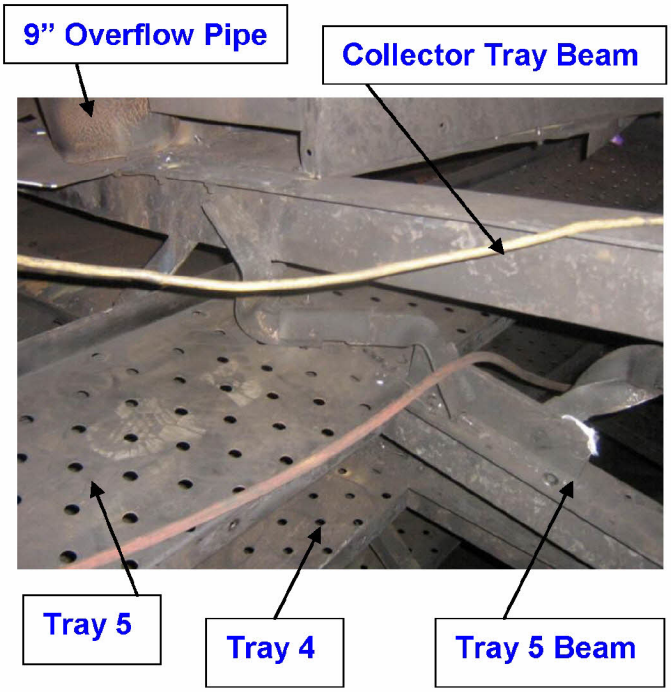
Action Required:

Need to fix the length of the sparger clips either by making a new sparger or adding extensions to the sparger to make the clip attached to the shell shorter. The extension could be fabricated from plate with a "T" or "I" cross section or simply from a piece of pipe. In addition the first 2 - 4 sets of holes of the sparger should be blocked off if any steam wear/erosion is discovered on the inlet nozzle (12 holes total). There are pictures in the electronic S/D file.

Support Beams/Trusses for Trays 1 thru 5 and Collector

Trays 1-5, the Collector Tray, and corresponding support trusses were found to be severely damaged. The bottom trays 1–5 were blown up into the collector tray. The Collector tray was not longer functional and looked like a ship wreck. The 6" meter pipe and two 9" over flow pipes that extend down from the sump on Tray 6 to the weir on the collector tray had been forced upward by the collector tray and damaged the tray 6 sump.

Pics of Damaged 1-5 Tray and Beams



Support Beams/Trusses for Trays 1 thru 5 and Collector (continued)

New replacement In-Kind 410 S stainless steel trusses were purchased as a contingency and were installed. New Trusses supplied by Sulzer MR# 224766. (original trusses were by Koch).

Field drilling was needed to attach some of the tray parts and to attach beams to column supports. Trusses were installed by bolting the beams together in the column and then welding the 1 ¼" X 1 ¼" tie angles to the top and bottom beams. See new equipment drawing for detail. Sulzer Drawings CA61181_01 Sheet 1-6.

Note: The contractor continuously lost materials for the trusses and trays. At the last minuet it was discovered that they had used 3/8" tray bolt instead of the supplied/required ½" 410 SS bolts for the truss beam to truss support clips (support clips are welded to vessel wall). After the new bolting was installed we discovered the contractor used ½" 304 and 316 SS bolting. We spoke with the Randy Sprouse (Crude Bin Leader) and learned there has not been a historical problem with chlorides in the bottom of the column and determined the bolts would last. Due to the info gathered and time constrains the bolts were left as is.

Action Required: Evaluate/Inspect integrity of bolt during next S/D. Determine whether the bolts need to be changed to ½" 410 SS bolting. 410 SS Bolts were ordered on MR 239459 but did not show up in time. These were sent to 8 Ware house for storage.

Trays 1 through 5

Stripping trays 1 through 5 were replaced. New trays were specified and ordered by Process Engineering (Garth Golly) PO# 10021516, from Sulzer.

Process Engineering summary: New Stripping trays 1-5 are of the same liquid and vapor capacity as the existing. Trays are of the same 410S metallurgy. Trays were upgraded from sieve to fixed valve type because of improved stripping efficiency. The Trays were also increased to 10 gauge thickness to provide better rigidity and hold-down capacity in case of wet steam.

Field drilling was required for installation because the new trays arrived with no holes for attaching them to the trusses & bolt strips. If these are ever ordered again from Sulzer, have Sulzer update their drawing to add the holes for bolting trays. There should be no reason way this cannot be accomplished since both the support trusses and trays are now made by Sulzer.

Action Required: During the next Turnaround inspect trays 1-5 and the collector for missing or severely corroded bolts and have them replaced with 410 SS. Particularly on tray 5 (some CS bolts were found at the last second after the tray manway was closed. There were not enough to justify a delay but should be looked at next Turn around.

Collector Tray

A new 410S S.S. replaced in-kind Collector tray was ordered on an expedited basis during the turnaround from Sulzer MR# 237486. The overflow meter pipe was repaired. The overlap dimension between the 6" meter pipe and the 9" over flow pipes in relation to the collector tray weir were fixed by extending the bottoms of the pipes. See the copy of EWO BE 301-E13 with field notes for final dimensions in the additional info section at the end of this post mortem report.

Note: For tray 1-5 and the collector all parts are 410S all bolting was to be 410 SS. CanaTex kept mixing up 410 SS with Carbon Steel. All the bolts we could find which were C.S. were changed out with 410 SS.

Action Required: Check for severely corroded C.S. bolts. See "Action Required" notes for Trays 1-5

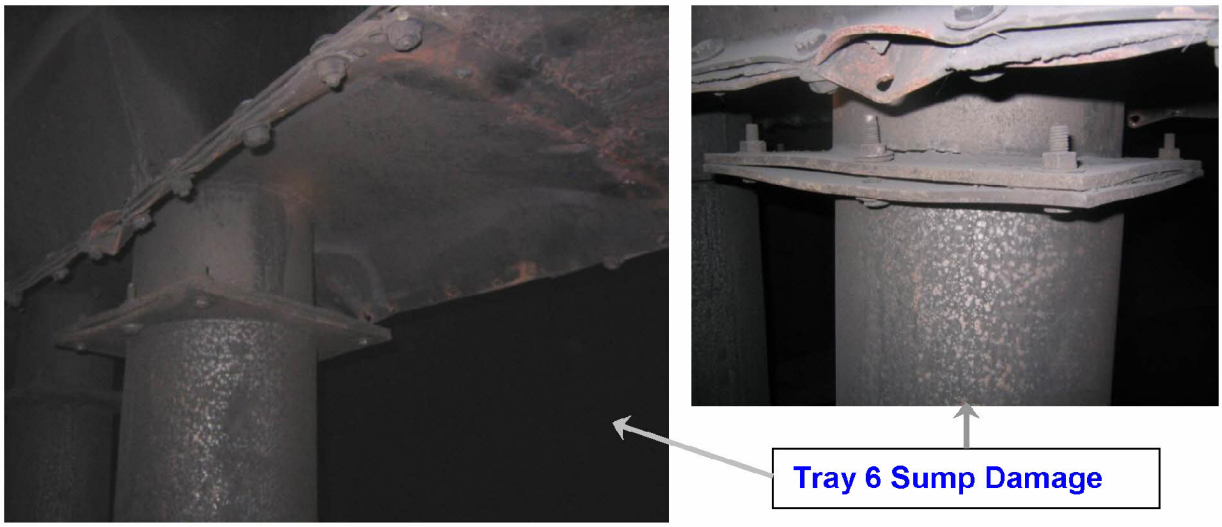
Ware Plate (Located in Flash Zone)

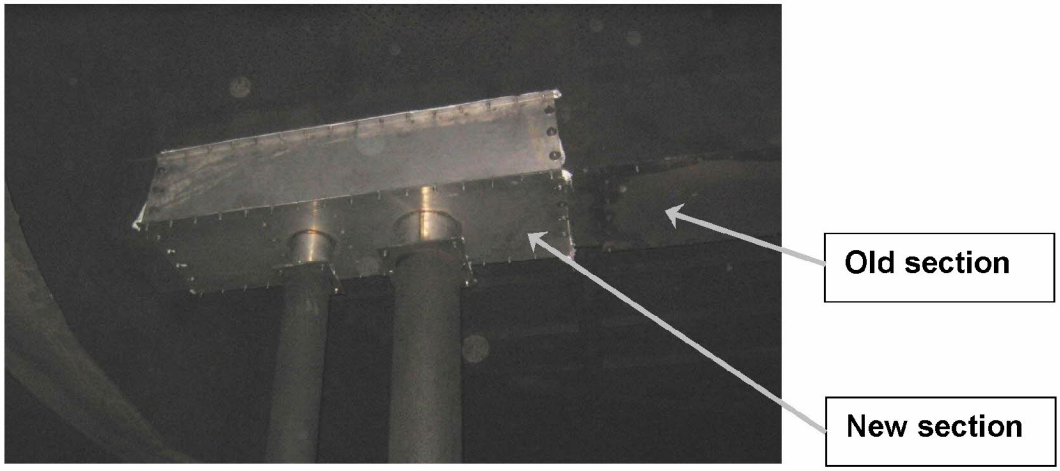
Cracks were found along most of the top weld of the ware plate. A 2ft section along one of the cracked welds had pulled away from the vessel wall about ¼". Not sure if the ¼" gap was a result of the plate bulging or poor fit up from when it was installed. The sides and bottom welds were in good shape. There was some bulging in the wear plate but was not an issue. The bulging may be due to thermal expiation of the wear plates since the bulges occurred where two plates butted up next to each other. Product has gotten behind the wear plate. This was evident because the weld along the bottom edge of the wear plate was stitch welded and liquid was seeping out. Because of this welding was not allowed the top edge of the wear plate, for fear that some hydrocarbon was still behind the plate. Pieces of angle were bolted to the bottom side of the vapor horn that pushed against the top edge of the wear plate. This was done to keep the ware Plate up against the vessel wall. There is no history of coke build up in this section of the column so the1/4" gap was not a concern.

Action Required: Have a contingency plan ready to fix or replace next Turnaround. I would order the material as part of the contingency planning and not wait till the turn around. Note: the wear plate repair performed on C-1160 in 2002 has held up very well.

Tray 6

The Sump on Tray 6 needed repair due to the upset from trays 1-5 and the collector. The 6" meter pipe and two 9" over flow pipes ,that extend down from the sump floor on tray 6 to the weir on the collector tray, had been forced upward by the collector tray and damaged the sump floor. The sump floor was bulge upward 3-4". The seams between the sump floor and sump walls no longer sealed and the overflow tube to sump floor weld was cracked/torn.





There are 4 sections to the sump. The two end sections were replaced and the two center sections were reused. The two end sections replaced consisted of the sump floor and sides. The floor contained the new 6" and 9" pipe connections complete with vortex breakers and metal screen.

The parts were replacement in–kind 410S SS supplied by Koch-glitsch for the rip off price of $57,000. MR# 238459. See marked up Drawing 12124-E-16 in the additional info section for more detail.

New sump parts sealed properly with the existing parts. The square flanges that connect to the 6" and 9" pipes were gasketed and sealed properly.

Trays 7-20

No work required and in satisfactory condition.

Trays 21

Machine shop fabricated 1 new sieve tray panel (material 410S SS 10 ga.) due to it being lost by the contractor.

Trays 22-24

No work required and in satisfactory condition.

Tray 25

During closure of the column, corrosion was noted on the tray 25 sump (diesel cut). It appeared that the sump had not been replaced when the tray was replaced during the previous shutdown. The tray had holed through in numerous locations and was close to failure. Because the discovery occurred during closure, there was not enough time to order replacement parts. A repair was made by installing 10 gauge 410 SS plate to cover the sump floor. Parts were fabricated via the Boiler Shop.

The existing sides of the sump were bent at 90 degrees, at the bottom, to provide a 1 inch horizontal ledge for the sump floor to attach (part of original fabrication). The sump floor sat on and was welded to these 1" horizontal ledges. This overlapping configuration made the edges of the bottom of the sump twice as thick as the center with little corrosion damage. In addition, there are 7" wide steel support beams every 67" along the sump.

The 410 SS repair plates were designed to run from one 7" support beam to the next and to clamp to the thicker part of the sump floor with large washers. Bolts were installed every 6" along the perimeter of the 410 SS plates and several bolts in the center of the plate. Figure 1 and Figure 2 show the underside of the sump floor. The bolts coming through the sump floor are clamped to the thicker part of the sump bottom. A 7" support beam is showed in the top of Figure 1.

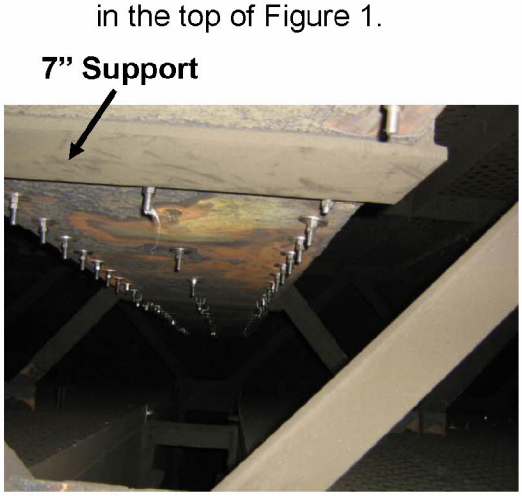


Figure 1

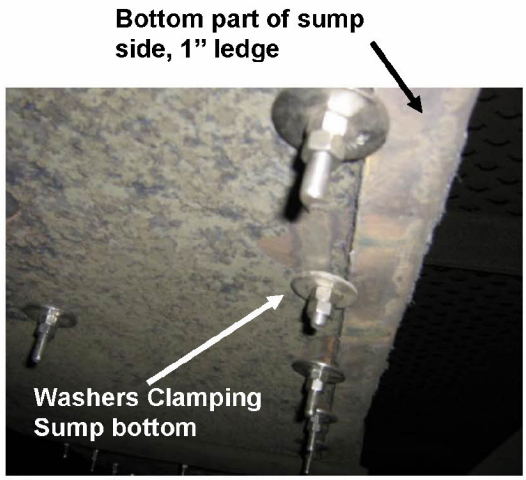


Figure 2

Figure 1 and Figure 2. View of the bottom of tray 25 sump floor after the repair.

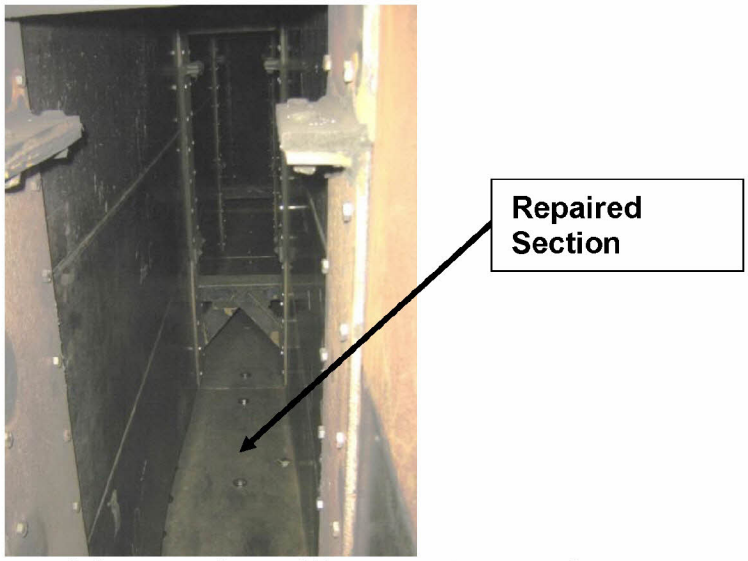


Figure 3. View of the top of tray 25 sump after repair.

The instructions in the EWO were not followed as specified. Some of the bolts were installed and were not clamping the thicker part of the sump and 7" support beam. However, it was determined that enough of the bolts and washers were clamping for the repair to work. The repair is not liquid tight, but it should leak less than the previous sump which was already holed through. Process had not reported any problems with that sidecut prior to the Shutdown, so the repair was deemed adequate.

Action Required: Replace sump assembly in-kind next S/D.

Trays 26-30
The existing trays were in bad shape. A few manway sections fell apart once unbolted. These were scheduled to be replaced.
Replace in-kind C.S. MR# 212757. Supplied by Koch-Glitsch

Trays 31-34
No work performed and in satisfactory condition.

Trays 35-37
Replaced with new redesigned C.S Sieve Trays by *Koch Glitsch*. Ordered and redesigned by Process Engineering (Garth Jolly).

(Process Engineering Overview)
MOC 15518 – C-1100 Replace ATCR Trays 35-37

Trays 35-37 in C-1100 have a very high liquid flow rate because of the high ATCR rate typically required to control column flooding.

The trays were previously converted to higher capacity trays to accommodate higher crude feed rates and distillate yields. However, in that design, to accommodate higher vapor flow rate

compromises were made that did not allow for higher liquid flow. The consequence of the liquid flow limitations is that there is "liquid holdup" in this section of the column (liquid flow through the downcomers is hydraulically limited). Liquid height is higher than designed and leads to higher pressure drop across the trays which ultimately leads to flooding and poor product quality.

The trays will allow for higher liquid flow in this section of the column. Downcomer area will be increased to allow for higher liquid flow and lower liquid heights in the downcomer areas. This will be accomplished without negatively affecting vapor traffic. Active area on the tray will be maintained at current levels by using Koch Glitsch Superfrac® tray active downcomer technology.

No change in instrumentation or advanced process control scheme will be required. Existing established RMPCT parameters for PD-001, PD-002 and PD-003 will need to be reevaluated as flooding conditions will be alleviated by this tray redesign. Process Engineering, Process Control and Operations will reevaluate and relax these limits during startup and initial unit optimization.

Tray 38-46
No work performed and in satisfactory condition.

Tray 47
Found to be damaged. Trays were thin and sieve holes enlarged. Portions of the tray corroded to failure. Part of the failure may have been contributed by the failed distributor header above tray 48. Replaced in-kind with C.S. Supplied by Sulzer Drawing # CA 70202-01 Sheet 1 and Sheet 4

Tray 48
Found to be corroded. Trays were thin and sieve holes enlarged. Portions of the tray corroded to failure. This was replaced in 1Q 2002 shutdown with 410S SS. Due to its short life the decision was made to upgrade to tray and integral supports to Monel. Other than material the new try was replaced in-kind and supplied by Sulzer. Drawing # CA 70202-01 Sheet 1 and Sheet 4

Distributors in C-1100

Overhead Reflux Distributor above Tray 48
Distributor was found covered with deposits and with many holes plugged. The two branches closest to the manway were missing their end caps due to corrosion. Distributor was covered which scale build up.

A new C.S. replacement in–kind header was fabricated by the Boiler Shop. The distributor has flat face flanges and CMG gaskets were used instead of existing spiral wound (see 1Q 2002 S/D Postmortem for prior gaskets used). In addition the first flange that bolts to the distributor (the one on the inside of the column and connected to the column wall) was replace due to corrosion.
-Distributor was not flow tested.

Note: Flat face flanges were used to minimize the gap between the flanges and hopefully minimize some of the corrosion between two adjacent flanges. In retrospect these gaskets should probably be full face CMG's or upgrade metallurgy on distributor so it does not corrode and use RF flanges.

Distributor Above Tray 37
The first flange in the column on both headers had 2 Bolts lose and blown out gasket on bottom of flange (total of two blown gaskets). The gaskets were composite "paper" gaskets.

All the distributor gaskets were upgraded to CMG. The new CMGs fit inside the bolt circle and were not full face gaskets. Flanges are flat face no repairs made to flanges.
-Distributor was not flow tested.

Distributor Above Tray 21 (ABCR Atmos' Bottoms Circ' Reflux) Distributor)

The first flange in on North West side of column had a blown gasket. All the gaskets were changed to CMG that fit inside the flange bolt circle (not full face gaskets).
-Flanges are flat face no repairs made to flanges.
-Distributor hole were checked and found clear.
-Distributor was not flow tested.

Distributor (Above Tray 9)
The original flanges on this distributor were plate flanges. One flange was bent with a failed gasket.

These gaskets were change to CMG's that fit on the inside of the flange bolt circle (not full face). When the contractors tightened up the plate flanges, almost every flange cracked at the flange to pipe weld. Flange Material 410 SS, pipe material 304 SS.

All the flanges were replaced with 304 SS 150# Slip-on flat face flanges and full face CMG's, except for the two flanges closet to the vessel wall. The flange connected to the vessels was not changed since it was not cracked. The adjacent flange on the distributor was replaced with the original style plate flange and gasketed with a full face CMG gaskets.
-Distributor was not flow tested.

Notes for distributor gaskets: All the distributor gaskets were changed to CMG's from the "paper" composite type gasket. The decision was made to make the gaskets fit inside the bolt circle and not cover the full face of the flat face flanges (the old paper gasket were full face gaskets). This was done in an effort to get high enough gasket loads on the gasket to develop proper seating stresses. In all reality with flat face flanges it would probably be best to stay with a full face gasket (even if it is CMG). The contractors really torqued down on the bolts causing the flanges to roll a little. A second advantage to the full face gasket is it helps protect the stud in-between the two flanges and eliminates any

space between the flanges were corrosion can occur (as seen on tray 48 distributor).

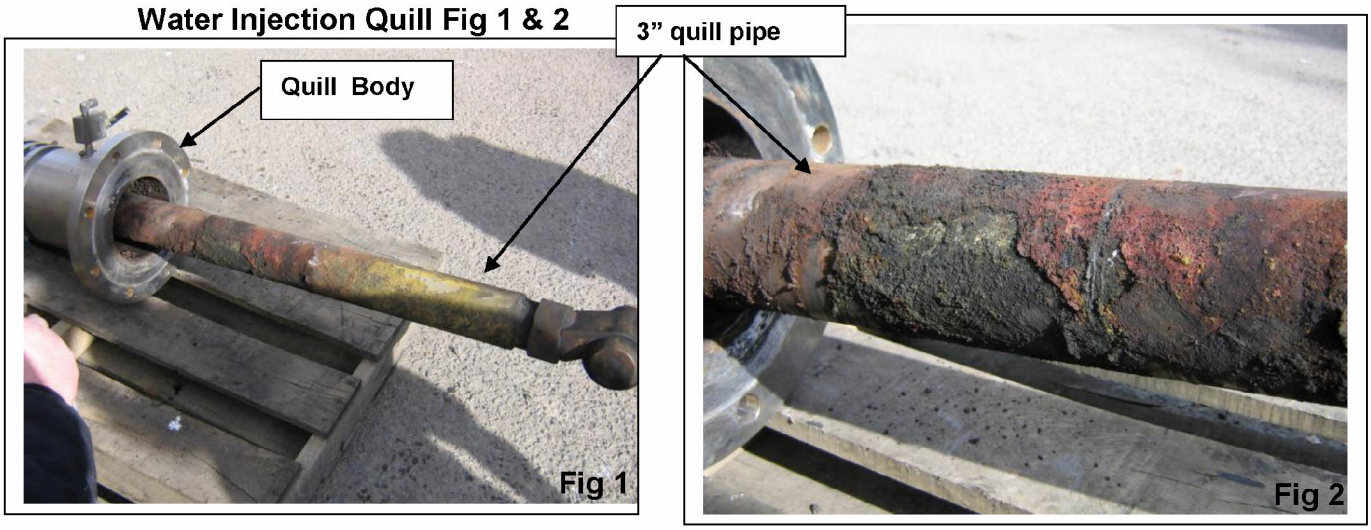
On the lower distributors using FR flanges with CMG's would be ok, because the corrosion on the flanges was minimal. At the distributor above tray 48 there was considerable corrosion to the C.S. distributor and flanges, therefore keeping flat face flanges with full face gaskets may be of benefit to keep the flange from corroding on both sides. It would also be a good idea to verify all the gasket surfaces are properly cleaned next time gaskets are changed out.

C-1100 overhead Line Water Injections Quill

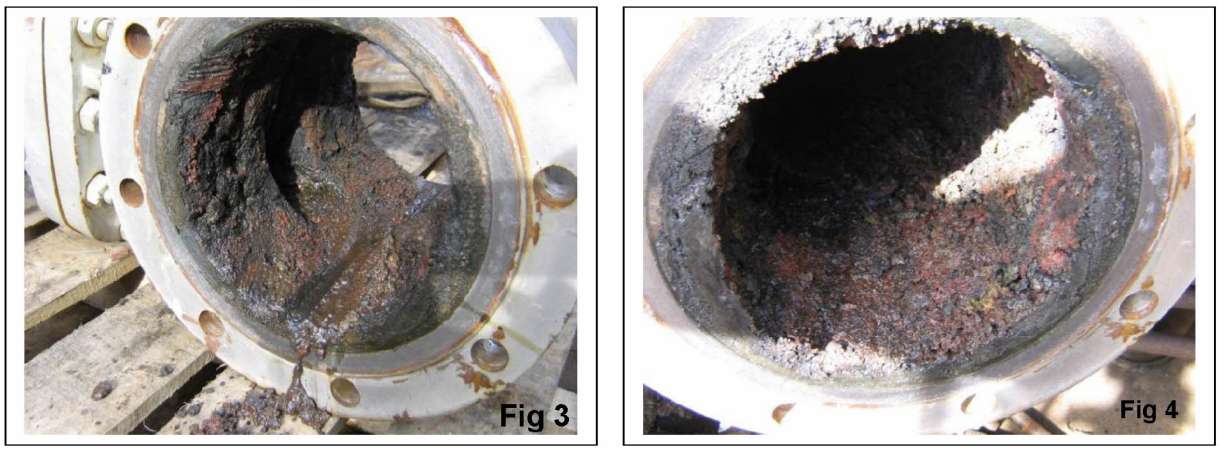
The water injection quill was pulled for the overhead line work. The quill was looked over by Inspections and Engineering. No issues found and no work/repairs required. There was a small amount of corrosion on the top of the 3" quill pipe that looked like snail tracks. Inspections pit gaged the corrosion at 0.020" on the 3" sch 80 pipe. This was not an issue.

Note: The quill was installed new in 2004, on the run. The quill is Hastelloy C and has packing that seals the 3" quill pipe to the quill body. The 3" quill pipe runs through the body. When the quill was removed (after 3 years of service) there was scale and build-up on the 3" quill pipe. The 8" gate valve that the quill passes through was full of scale and build-up. With the build up and minor snail trail like corrosion on the quill one could conclude that though a new quill can be installed on the run, it may not necessarily be removable on the run. Even if the quill could be retraced without leaking there is no way the 8" gate valve would seal to isolate the retraced quill. It may be a good idea to consider replacing the quill with a Hastelloy C fixed quill. This would eliminate the 8" Gate valve, the packing on the quill, and free up space on the platform.

Water Injection Quill Fig 1 & 2



8" Gate Valve: Fig 3 & 4



C-1160 Vacuum Column **Scott Woolley/Craig Dillon Need to add reference !!!!**

We were prepared for but did not need to perform any hot work inside of C-1160 over a packed bed. Maintenance Procedures were used for procedures if welding was required over packed beds.

"Bottom to Top" Review

Bottom Head

Inspected and found in serviceable condition. No work required.

Vortex Breakers

Removed coke build up and Cleaned. Cleaned spare unused outlets.

Nozzle N12 (Below Tray 1 Seal Pan)

Installed (1) Steam Sparger. Material Inconel 825. Per EWO BE306-E5 and BE306-E5 Rev1. The sparger was too short and the attachment clip was lengthened to accommodate.

Action Required:

Need to assess and fix the length of the sparger clips, either by making a new sparger or adding an extension to the end of the existing sparger to make the clip attached to the shell shorter. The extension could be fabricated from plate with a "T" or "I" cross section or simply from a piece of pipe. In addition evaluate the location of the first 2 - 4 sets of holes should on the sparger in relation to the inlet nozzle. And determine if any action is required.

Stripping Section Trays 1-5

Trays 1, 2, 3, 4, & 5 appeared to be in serviceable condition. Trays were cleaned. Some coke build up in seal pan but not excessive.
Minor repair performed if any. Repairs were:

>Tray 1: installed misc tray supports
>Tray 4: replaces downcomer sealing strip

Nozzle N11 Bottom Quench Line

Replaced blown out internal gasket on quench line.

Collector Tray (below Flash Zone & above Stripping Section Tray 5)

Appeared to be in good condition, no work was required.

Wear plate and Vapor Horn (Flash Zone)

Found in good condition. No work required.

Note: Wear Plate was entirely replaced during 1Q 2002 D&R S/D. The repair held up well. No issues found. (refer to 2002 Post mortem).

Overflash Draw Off Collector Tray

- In serviceable condition no work required.
- Significant amount of coke build up. Build up allowed coke to get into P-1187 Suction.
- Tray was cleaned and P-1187 line cleared.
- A past shutdown report motioned embrittlement of the tray. No evaluation done on weather it was embrittled or not. No issues.

Overflash Quench Distributor

The west distributor had two broken clips one on north end of vessel and one on south end. Weld repair made to fix clip.
EWO#: BE306-E9R1

Bed 5 / Grid Packing

- Bottom layers of Bed were disrupted. Bed was removed to repair disrupted packing and evaluated coke deposits if any. Only minimal amounts of cike found. No excessive coke buildup.

The two pictures are the Bottom of Bed 5 Packing Looking up.


- Bed 5 was reassembled using with a combination of existing packing and all of the contingency Grid packing.
- Note: 30% of bed packing was purchased for contingency by PED.

Would evaluate/determine is a hold down is required for Bed 5 if found upset in the future. Note: was found upset in 2002 S/D.

Wash Oil Distributor

No Work Required.

Bed 4

No work required

Bed 3

No work required on the packing.
Distributor for bed 3 had several plugged holes which were cleared.

Bed 2

- Replaced Packing per PED request.
- Bed 2 is suspect to only being installed with 11 layers and it should have 12 layers. The contractor assured the engineers the thickness difference was from the manufacture tolerance of the packing and all 12 layers had been installed. To fix the spacing between the packing and the Downconer Chimneys, extensions were install on the Downcomer Chimneys.

  After the Shutdown was complete, brand new "Surplus" packing left over form the S/D was found in 8 Warehouse. Turns out the amount left over is exactly 1 layers worth of packing.
- Distributor for bed 2 had several plugged holes which were cleared.
- Bed 2 Support Ring had a crack in the attachment weld to the vessel in one spot. Crack was removed via grinding.

Action Required: Next time the Bed 2 is removed, engineering PED or DED needs to confirm the # of layers. There should be 12 layers per design. Take

measurements to determine where top layer should stop so one can verify packing was installed properly.

If this is not verified it is very likely that the next time the packing is removed "contractors" may mark the wall of the vessel and use it as the stopping point for installing any new packing, and if it is incorrect it will not get corrected.

Ammonia Injection Nozzle (N72)

A new ammonia injection quill was installed in C-1160 overhead line. MR# 203125. Existing 2" ammonia injection quill at Bed 2 was left in place. EWO# BE148-E1. MOC 15465 (per Best Practice)
Need to verify is the old quill still useable or was it removed??

Bed 1 (Top Most Bed)

- First few layers of packing were found displaced/disrupted.
- All packing was removed and replaced with new in its entirety.
- Top of Bed 1 could benefit from a hold down for the packing. Need for hold down was eliminated since new distributor trough sits on top of the packing.
- Replaced Packing per PED. Material is ???? **(Was there a reason why?)**
- Bed 1 Support Ring attachment weld was blend ground all the way around to remove crack (Crack was removed via grinding).

Note: most of the distributor holes were clear except as noted above.

VTCR Distributor "Vac' Top Circ' Reflux" (Above Bed 1)

- Spray Distributor nozzles were found clear and in good condition.
- Spray distributor was removed and replaced with new trough system which sits directly above the packing and in some cases rests on the packing.

New Distributor was designed/specified and purchased though Process Engineering. New trough system was supplied by Sulzer.

- The Distributor Trough is supported by the existing Distributor support clips attached to the vessel wall as well as resting on the packing.
- Distributor support clip closest to the manway developed a crack after being hammer adjusted by the contractor and was weld repaired.

Top Head

Inspected and found in serviceable condition. No work required.

C-1160 - "Wash Oil & "VTCR" Distributor Water Testing

See EWO # BE306-E6R1 for complete description of test.

The required flow rate from PED was 2000-2200 GPM. The original plan called for multiple Baker tanks (about 4). Only one was supplied do to the available space. The tank supplied had a 4" outlet instead of the required 8" outlet. The tank was to be simultaneously filled from two sources as it was being pumped out, to allow the test to last the required duration. This was not available due to unplanned event. The test barely worked. The min flow rate was reached for a brief minuet at about 1000 GPM. As the tank drained the pump lost its required suction head. The 4" suction being the main issue.

The water that did make it to the distributor filtered trough the column and poured out the bottom head (as planned). The sewer drains were all covered for in plant hot work and left covered (not planned). This caused flooding to occur at the base of C-1160 (really not planned).

In conclusion, enough water made it to the trough to verify it was working properly. There is little point to developing a test plan if the correct equipment or connections are not supplied. If it is a critical test double check to make sure everything is supplied and connected a needed.

C-1190

Column was cleaned/Hydro blasted and inspected. There were a number of t min issues which required weld building.

- Weld build required in bottom head due to Internal corrosion EWO BE311-E2
- Weld build required externally all over due to corrosion under insulation. EWO #: BE311-E1 and BE311-E3.
- About 40 random bubble caps were replaced per Process Engineering request.
- At the bottom of the column there was a baffle installed upside down. It had been like that at least since 2002. We believe the baffle was flipped during a S/D to allow for better access, was forgotten, and left upside down. There was no process information that stated the vessel was operating incorrectly due to the baffle being upside down. The baffle was installed correctly prior to closing the vessel.

White Space

White Space

White Space